

## CLAIMS

- 5/11/98
- 1 1. An apparatus comprising:
- 2 at least one processor;
- 3 a memory coupled to at least one processor;
- 4 a cluster servicer residing in said memory, said cluster servicer facilitating cluster
- 5 messaging with at least one other computer without requiring an intervening
- 6 dedicated local area network to said at least one other computer.
- 1 2. The apparatus of claim 1 further comprising a network message servicer residing in
- 2 said memory, said network message servicer routing at least one cluster message from said
- 3 cluster servicer to said at least one other computer.

1 3. The apparatus of claim 2 wherein said network message servicer comprises:  
 2 a User Datagram Protocol, said User Datagram Protocol formatting said at least  
 3 one cluster message to be sent to said at least one other computer;  
 4 an Internet Protocol, said Internet Protocol routing said at least one formatted  
 5 cluster message to said at least one other computer without requiring an  
 6 intervening dedicated local area network to said at least one other computer.

1 4. The apparatus of claim 2 wherein said cluster servicer includes a cluster destination  
 2 address table, said cluster destination address table comprising at least one network  
 3 address for said at least one other computer, and wherein said cluster servicer retrieves  
 4 said at least one network address for said at least one other computer from said cluster  
 5 destination address table to facilitate cluster messaging with said at least one other  
 6 computer without requiring an intervening dedicated local area network to said at least  
 7 one other computer.

1 5. The apparatus of claim 4 wherein said cluster destination address table further  
 2 comprises cluster status information for said at least one other computer.

- 1 6. The apparatus of claim 4 wherein said cluster destination address table further
- 2 comprises adapter information for said at least one other computer.

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1 7. An apparatus comprising:  
2 at least one processor;  
3 a memory coupled to at least one processor;  
4 a network message servicer residing in said memory; and  
5 a cluster servicer residing in said memory, said cluster servicer including a cluster  
6 destination address table, said cluster destination address table including at least  
7 one address for at least one other apparatus networked to said apparatus, wherein  
8 a message to one of said at least one other apparatus can be sent by said cluster  
9 servicer retrieving said at least one address for said at least one other apparatus  
10 from said cluster destination address table and passing said retrieved address and  
11 said message to said network servicer, wherein said network servicer routes said  
12 message to said at least one other apparatus.

1 8. The apparatus of claim 7 wherein said cluster destination address table further  
2 comprises adapter information for each of said at least one address for at least one other  
3 apparatus networked to said apparatus.

- 1 9. The apparatus of claim 7 wherein said cluster destination address table further
- 2 comprises status information for each of said at least one address for at least one other
- 3 apparatus networked to said apparatus.

09173090-101598

1 10. The apparatus of claim 7 operating as a computer cluster, said computer cluster  
2 comprising at least one other apparatus networked to said apparatus, wherein each  
3 apparatus in said computer cluster comprises:

4 at least one processor;

5 a memory coupled to at least one processor;

6 a User Datagram Protocol residing in said memory, said User Datagram Protocol  
7 formatting at least one packet to be sent between apparatuses in said computer  
8 cluster;

9 an Internet Protocol residing in said memory, said Internet Protocol routing said at  
10 least one packet between apparatuses in said computer cluster; and

11 a cluster servicer residing in said memory, said cluster servicer including a cluster  
12 destination address table, said cluster destination address table including at least  
13 one Internet address for said each apparatus in said computer cluster, wherein a  
14 message can be sent to one of said each apparatus in said computer cluster by said  
15 cluster servicer determining one of said at least one Internet address of said one of  
16 said each apparatus in said computer cluster from said cluster destination address  
17 table and passing said determined Internet address and said message to said User  
18 Datagram Protocol, wherein said User Datagram Protocol formats said determined  
19 Internet address and said message into at least one packet and passes said at least  
20 one packet to said Internet Protocol, wherein said Internet Protocol routes said at  
21 least one packet to said one of said each apparatus in said computer cluster.

1 11. The apparatus of claim 7 wherein said cluster destination address table includes at  
 2 least one Internet address for said at least one other apparatus networked to said  
 3 apparatus, and wherein a message to one of said at least one other apparatus can be sent  
 4 by said cluster servicer retrieving said at least one Internet address for said at least one  
 5 other apparatus from said cluster destination address table and passing said retrieved  
 6 Internet address and said message to said network servicer.

1 12. The apparatus of claim 11 wherein said network message servicer comprises:  
 2 a User Datagram Protocol which formats at least one packet from said message  
 3 and said retrieved Internet address; and  
 4 an Internet Protocol, said Internet protocol routing said at least one packet to said  
 5 one of said at least one other apparatus networked to said apparatus.

1 13. The apparatus of claim 12 wherein said at least one other apparatus networked to  
 2 said apparatus is networked through a plurality of routers, and wherein said Internet  
 3 Protocol comprises specific routing directions indicating which router of said plurality of  
 4 routers should be used for routing said at least one packet to said at least one other  
 5 apparatus.

# 2020-21

- , each computer in said cluster;  
a protocol residing in said memory, said protocol defining a packet to be sent between said computers;  
a table residing in said memory, said table defining a cluster destination for each computer in said cluster;  
an address table entry comprising a cluster address for each of said at least one computer;  
a protocol for each of said at least one computer;  
an address table entry comprising a cluster address for each of said at least one computer;



(Claim 14 continued)

17 wherein said cluster server sends a cluster message to a destination computer in said  
18 cluster of computers by determining an Internet address for said destination computer  
19 from said cluster destination address table entry for said destination computer and passing  
20 said determined Internet address of said destination computer and said cluster message to  
21 said User Datagram Protocol, wherein said User Datagram Protocol formats said  
22 determined Internet address and said cluster message into a packet and passes said packet  
23 to said Internet Protocol, wherein said Internet Protocol routes said packet to said  
24 destination computer.

1 15. The cluster of computers of claim 14 wherein said Internet Protocol on said each  
2 computer in said cluster of computers includes a routing table, said routing table including  
3 at least one routing table entry, said at least one routing table entry including a subnet  
4 address and corresponding routing direction for said subnet address, and wherein at least  
5 one additional routing table entry exists in said routing table for each computer in said  
6 cluster of computers that is attached to a plurality of routers, said at least one additional  
7 routing table entry including a subnet address and corresponding routing direction for said  
8 subnet address that specifies to which router of said plurality of routers to route said at  
9 least one packet.

1 16. The cluster of computers of claim 14 wherein said cluster servicer in each  
2 computer in said cluster of computers can employ said cluster destination address table,  
3 said User Datagram Protocol, and said Internet Protocol to route all cluster messages  
4 necessary to maintain said cluster of computers.

1 17. The cluster of computers of claim 14 wherein said cluster servicer can determine  
2 from said status information in said cluster destination address table whether a network  
3 adapter for one of said each computer in said cluster of computers is reachable or  
4 unreachable.

1 18. The cluster of computers of claim 14 wherein said cluster servicer can determine  
2 from said adapter information in said cluster destination address table how to assign  
3 cluster responsibilities to said each computer in said cluster of computers.

1 19. The cluster of computers of claim 14 wherein said cluster servicer can determine  
2 from said adapter information in said cluster destination address table how to size cluster  
3 messages to each network adapter on said each computer in said cluster of computers.

20. The cluster of computers of claim 14 wherein at least one computer in said cluster of computers has a plurality of network adapters, and wherein each cluster destination address table entry corresponding to said at least one computer in said cluster of computers with a plurality of network adapters includes an Internet address for each of said plurality of network adapters, said plurality of Internet addresses ordered preferentially in said cluster destination address table entry, and wherein said cluster servicer can send a cluster message to a destination computer with a plurality of adapters by determining a primary Internet address for said destination computer with a plurality of adapters from said cluster destination address table entry corresponding to said destination computer with a plurality of network adapters.

21. The cluster of computers of claim 20 wherein said cluster servicer can send a cluster message to a destination computer with a plurality of adapters by determining an alternate Internet address for said destination computer with a plurality of adapters from said cluster destination address table corresponding to said destination computer with a plurality of adapters, when a timely response from said destination computer with a plurality of adapters is not received after sending a cluster message addressed to said primary Internet address for said destination computer with a plurality of adapters.

1 22. A method comprising the steps of:  
 2 creating network address information for each computer in a cluster configuration;  
 3 storing said network address information on said each computer in said cluster  
 4 configuration; and  
 5 employing said network address information in conjunction with a network  
 6 message servicer for cluster communications in said cluster configuration beyond a  
 7 single local area network.

1 23. The method of claim 22 further comprising the steps of:  
 2 creating routing information for each computer connected to a plurality of routers  
 3 in said cluster configuration, said routing information identifying which router of  
 4 said plurality of routers to employ in communicating between said each computer  
 5 connected to said plurality of routers in said cluster configuration; and  
 6 storing said routing information on each said computer connected to said plurality  
 7 of routers in said cluster configuration.

1 24. The method of claim 22 wherein the step of creating network address information  
2 for said each computer in said cluster configuration comprises the step of creating a  
3 cluster destination address table on said each computer in said cluster configuration,  
4 wherein the step of creating said cluster destination address table comprises creating a  
5 cluster destination address table entry for said each computer in said cluster configuration,  
6 said cluster destination address table entry including at least one network address for a  
7 computer in said cluster configuration corresponding to said cluster destination address  
8 table entry.

1 25. The method of claim 24 wherein the step of employing said network address  
2 information in conjunction with a network message servicer for cluster communications in  
3 said cluster configuration beyond a single local area network comprises the steps of:

4 retrieving said at least one network address from at least one cluster destination  
5 address table entry corresponding to at least one computer in said cluster  
6 configuration;

7 employing said network message servicer to send at least one cluster message to  
8 said at least one computer in said cluster configuration by passing said retrieved at  
9 least one network address for said at least one computer in said cluster  
10 configuration along with said at least one cluster message to a network message  
11 servicer, said network message servicer routing said at least one cluster message to  
12 said at least one computer in said cluster configuration using said retrieved at least  
13 one network address.

1 26. The method of claim 25 wherein the step of employing said network message  
 2 servicer to send at least one cluster message to said at least one computer in said cluster  
 3 configuration comprises the step of passing said retrieved at least one network address for  
 4 said at least one computer in said cluster configuration along with said at least one cluster  
 5 message to a User Datagram Protocol, said User Datagram Protocol formatting said  
 6 retrieved at least one network address for said at least one computer in said cluster  
 7 configuration and said at least one cluster message into at least one packet, said User  
 8 Datagram Protocol passing said at least one packet to an Internet Protocol, said Internet  
 9 Protocol routing said at least one packet to said at least one computer in said cluster  
 10 configuration.

1 27. The method of claim 24 wherein the step of creating a cluster destination address  
 2 table for said each computer in said cluster configuration comprises the step of creating a  
 3 cluster destination address table entry for said each computer in said cluster configuration,  
 4 said cluster destination address table entry including a primary network address and at  
 5 least one alternate network address for said computer in said cluster configuration  
 6 corresponding to said cluster destination address table entry.

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28. The method of claim 27 wherein the step of employing said network address information in conjunction with a network message servicer for cluster communications in said cluster configuration beyond a single local area network comprises the steps of:

retrieving at least one network address from at least one cluster destination address table entry corresponding to at least one computer in said cluster configuration;

employing said network message servicer to send at least one cluster message to said at least one computer in said cluster configuration by passing said primary network address for said at least one computer in said cluster configuration along with said at least one cluster message to a network message servicer, said network message servicer routing said at least one cluster message to said at least one computer in said cluster configuration using said primary network address;

awaiting a reply to said at least one cluster message sent to said at least one computer in said cluster configuration using said primary network address;

employing said network message servicer to send at least one cluster message to said at least one computer in said cluster configuration by passing said at least one alternate network address for said at least one computer in said cluster configuration along with said at least one cluster message to a network message servicer, said network message servicer routing said at least one cluster message to said at least one computer in said cluster configuration using said at least one alternate network address, when said reply to said at least one cluster message sent to said at least one computer in said cluster configuration using said primary network address is not received in a timely manner.

1 29. The method of claim 22 wherein the step of storing said network address  
2 information on said each computer in said cluster configuration comprises the step of  
3 storing a copy of said network address information on a first computer in said cluster  
4 configuration, said first computer updating said network address information with adapter  
5 information about said first computer; said first computer sending a copy of updated  
6 network address information to each other computer in said cluster configuration; said  
7 each other computer in said cluster configuration updating said network address  
8 information with adapter information about said each other computer in said cluster  
9 configuration; said each computer in said cluster configuration exchanging said updated  
10 network address information such that said each computer in said cluster configuration  
11 receives an identical copy of said updated network address information .

1 30. The method of claim 29 wherein the steps of:  
2 updating said network address information about said first computer comprises the  
3 step of updating said network address information with adapter type, maximum  
4 transmission unit, subnet mask, and class of service for said first computer; and  
5 updating said network address information about said each other computer in said  
6 cluster configuration comprises the step of updating said network address  
7 information with adapter type, maximum transmission unit, subnet mask, and class  
8 of service for each other computer in said cluster configuration.



1 31. A method of communicating between computers in a cluster comprising the steps  
2 of:

3 creating a cluster destination address table on said each computer in said cluster,  
4 said cluster destination address table including a cluster destination address table  
5 entry for said each computer in said cluster, said cluster destination address table  
6 entry including a primary network address and at least one alternate network  
7 address for said computer in said cluster corresponding to said cluster destination  
8 address table entry;

9 storing said cluster destination address table on said each computer in said cluster;  
10 and

11 employing said cluster destination address table in conjunction with a network  
12 message servicer for communicating between computers in said cluster without  
13 requiring an intervening dedicated local area network.

1 32. The method of claim 31 further comprising the steps of:

2 adding routing information to said network message servicer for each computer  
3 connected to a plurality of routers in said cluster, said routing information  
4 identifying which router of said plurality of routers to employ in communicating  
5 between said each computer connected to said plurality of routers in said cluster.

1 33. The method of claim 31 wherein the step of employing said cluster destination  
2 address table in conjunction with a network message servicer for communicating between  
3 computers in said cluster without requiring an intervening dedicated local area network  
4 comprises the steps of:

5 retrieving at least one primary network address from at least one cluster  
6 destination address table entry corresponding to at least one computer in said  
7 cluster; and

8 employing said network message servicer to communicate with at least one  
9 computer in said cluster by passing said retrieved at least one primary network  
10 address for said at least one computer in said cluster along with at least one cluster  
11 message to said network message servicer, said network message servicer routing  
12 said at least one cluster message to said at least one computer in said using said  
13 retrieved at least one primary network address.

1 34. The method of claim 33 wherein the step of employing said network message  
 2 servicer to communicate with at least one computer in said cluster comprises the step of  
 3 passing said retrieved at least one primary network address for said at least one computer  
 4 in said cluster along with at least one cluster message to a User Datagram Protocol, said  
 5 User Datagram Protocol formatting said retrieved at least one primary network address  
 6 for said at least one computer in said cluster and said at least one cluster message into at  
 7 least one packet, said User Datagram Protocol passing said at least one packet to an  
 8 Internet Protocol, said Internet Protocol routing said at least one packet to said at least  
 9 one computer in said cluster.

1 35. The method of claim 31 wherein the step of storing said cluster destination address  
 2 table on said each computer in said cluster comprises the step of storing a copy of said  
 3 cluster destination address table on a first computer in said cluster, said first computer  
 4 updating said cluster destination address table with adapter information about said first  
 5 computer; said first computer sending a copy of an updated cluster destination address  
 6 table to each other computer in said cluster; said each other computer in said cluster  
 7 updating said cluster destination address table with adapter information about said each  
 8 other computer in said cluster; said each computer in said cluster exchanging said updated  
 9 cluster destination address table such that said each computer in said cluster receives an  
 10 identical copy of said updated cluster destination address table.

1 36. The method of claim 35 wherein the steps of:

2 updating said cluster destination address table with adapter information about said  
 3 first computer comprises the step of updating said cluster destination address table  
 4 with adapter type, maximum transmission unit, subnet mask, and class of service  
 5 for each said primary network address and said each at least one alternate network  
 6 address for said first computer; and

7 updating said cluster destination address table with adapter information about said  
 8 each other computer in said cluster comprises the step of updating said cluster  
 9 destination address table with adapter type, maximum transmission unit, subnet  
 10 mask, and class of service for each said primary network address and said each at  
 11 least one alternate network address for said each other computer in said cluster.

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1 37. A program product comprising:

2 (A) a cluster servicer, said cluster servicer facilitating cluster messaging with at  
3 least one other computer without requiring an intervening dedicated local area  
4 network to said at least one other computer; and

5 (B) signal bearing media bearing said cluster servicer.

1 38. The program product of claim 37 wherein said signal bearing media comprises  
2 transmission media.

1 39. The program product of claim 37 wherein said signal bearing media comprises  
2 recordable media.

1 40. The program product of claim 37 further comprising a network message servicer,  
2 said network message servicer routing at least one cluster message from said cluster  
3 servicer to said at least one other computer.

1 41. The program product of claim 40 wherein said network message servicer  
2 comprises:

3 a User Datagram Protocol, said User Datagram Protocol formatting said at least  
4 one cluster message to be sent to said at least one other computer;

5 an Internet Protocol, said Internet Protocol routing said at least one formatted  
6 cluster message to said at least one other computer without requiring an  
7 intervening dedicated local area network to said at least one other computer.

1 42. The program product of claim 40 wherein said cluster servicer includes a cluster  
2 destination address table, said cluster destination address table comprising at least one  
3 network address for said at least one other computer, and wherein said cluster servicer  
4 retrieves said at least one network address for said at least one other computer from said  
5 cluster destination address table to facilitate cluster messaging with said at least one other  
6 computer without requiring an intervening dedicated local area network to said at least  
7 one other computer.

1 43. The program product of claim 42 wherein said cluster destination address table  
2 further comprises cluster status information for said at least one other computer.

- 1 44. The program product of claim 42 wherein said cluster destination address table
- 2 further comprises adapter information for said at least one other computer.

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A program product comprising:

2 (A) a network message servicer;

3 (B) a cluster servicer, said cluster servicer including a cluster destination address  
4 table, said cluster destination address table including at least one address for each  
5 of a plurality of apparatuses in a computer cluster, wherein a message to one of  
6 said plurality of apparatuses can be sent by said cluster servicer retrieving one of  
7 said at least one address for said one of said plurality of apparatuses from said  
8 cluster destination address table and passing said retrieved address and said  
9 message to said network servicer, wherein said network servicer routes said  
10 message to said one of said plurality of apparatuses; and

11 (C) signal bearing media bearing said network message servicer and said cluster  
12 servicer.

1 46. The program product of claim 45 wherein said signal bearing media comprises  
2 transmission media.

1 47. The program product of claim 45 wherein said signal bearing media comprises  
2 recordable media.



1 48. The program product of claim 45 wherein said cluster destination address table  
2 further comprises adapter information for said each of said plurality of apparatuses.

1 49. The program product of claim 45 wherein said cluster destination address table  
2 further comprises status information for said each of said plurality of apparatuses.

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1 50. The program product of claim 45 comprising:  
2 a User Datagram Protocol, said User Datagram Protocol formatting at least one  
3 packet to be sent between said plurality of apparatuses in said computer cluster;  
4 an Internet Protocol, said Internet Protocol routing said at least one packet  
5 between said plurality of apparatuses in said computer cluster; and  
6 a cluster servicer, said cluster servicer including a cluster destination address table,  
7 said cluster destination address table including at least one Internet address for  
8 each of said plurality of apparatuses in said computer cluster, wherein a message  
9 can be sent to one of said plurality of apparatuses in said computer cluster by said  
10 cluster servicer determining one of said at least one Internet address for said one of  
11 said plurality of apparatuses in said computer cluster from said cluster destination  
12 address table and passing said determined Internet address and said message to  
13 said User Datagram Protocol, wherein said User Datagram Protocol formats said  
14 determined Internet address and said message into at least one packet and passes  
15 said at least one packet to said Internet Protocol, wherein said Internet Protocol  
16 routes said at least one packet to said one of said plurality of apparatuses in said  
17 computer cluster.

1 51. The program product of claim 45 wherein said cluster destination address table  
2 includes at least one Internet address for said each of said plurality of apparatuses in said  
3 computer cluster, and wherein a message to one of said plurality of apparatuses can be  
4 sent by said cluster servicer retrieving one of said at least one Internet address for said one  
5 of said plurality of apparatuses from said cluster destination address table and passing said  
6 retrieved Internet address and said message to said network servicer.

1 52. The program product of claim 51 wherein said network message servicer  
2 comprises:

3 a User Datagram Protocol which formats at least one packet from said message  
4 and said retrieved Internet address; and

5 an Internet Protocol, said Internet protocol routing said at least one packet to said  
6 one of said plurality of apparatuses networked to said apparatus.

1 53. The program product of claim 52 wherein said at least two of said plurality of  
2 apparatuses in said computer cluster are networked through a plurality of routers, and  
3 wherein said Internet Protocol comprises specific routing directions indicating which  
4 router of said plurality of routers should be used for routing said at least one packet  
5 between said two of said plurality of apparatuses in said computer cluster networked  
6 together through a plurality of routers.

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54. A program product comprising:

2 a User Datagram Protocol, said User Datagram Protocol formatting at least one  
3 packet to be sent between computers in a cluster of computers;

4 an Internet Protocol suite, said Internet Protocol routing said at least one packet  
5 between computers in said cluster of computers; and

6 a cluster servicer, said cluster servicer including a cluster destination address table,  
7 said cluster destination address table including a cluster destination address table  
8 entry for each computer in said cluster of computers, said each cluster destination  
9 address table entry comprising:

10 an Internet address for each network adapter;

11 status information for said each network adapter; and

12 adapter information for said each network adapter;

13 wherein said cluster servicer sends a cluster message to a destination computer in said  
14 cluster of computers by determining an Internet address for said destination computer  
15 from said cluster destination address table entry for said destination computer and passing  
16 said determined Internet address of said destination computer and said cluster message to  
17 said User Datagram Protocol, wherein said User Datagram Protocol formats said  
18 determined Internet address and said cluster message into a packet and passes said packet  
19 to said Internet Protocol, wherein said Internet Protocol routes said packet to said  
20 destination computer.

1 55. The program product of claim 54 wherein said signal bearing media comprises  
2 transmission media.

1 56. The program product of claim 54 wherein said signal bearing media comprises  
2 recordable media.

1 57. The program product of claim 54 wherein said Internet Protocol includes a routing  
2 table, said routing table including at least one routing table entry, said at least one routing  
3 table entry including a subnet address and corresponding routing direction for said subnet  
4 address, and wherein at least one additional routing table entry exists in said routing table  
5 for each computer in said cluster of computers that is attached to a plurality of routers,  
6 said at least one additional routing table entry including a subnet address and  
7 corresponding routing direction for said subnet address that specifies to which router of  
8 said plurality of routers to route said at least one packet.

1 58. The program product of claim 54 wherein said cluster servicer can employ said  
2 cluster destination address table, said User Datagram Protocol, and said Internet Protocol  
3 to route all cluster messages necessary to maintain said cluster of computers.

1 59. The program product of claim 54 wherein said cluster servicer can determine from  
 2 said status information in said cluster destination address table whether a network adapter  
 3 for one of said each computer in said cluster of computers is reachable or unreachable.

1 60. The program product of claim 54 wherein said cluster servicer can determine from  
 2 said adapter information in said cluster destination address table how to assign cluster  
 3 responsibilities to said each computer in said cluster of computers.

1 61. The program product of claim 54 wherein said cluster servicer can determine from  
 2 said adapter information in said cluster destination address table how to size cluster  
 3 messages to each network adapter on said each computer in said cluster of computers.

